ALUMINUM

Project Fact Sheet

DYNAMIC INERT METAL ANODES

BENEFITS

Development and commercialization of inert anode technology combined with wetted cathode technology will potentially result in:

- Saving 10 trillion Btu annually
- Reducing 7 million metric tons of greenhouse gas emissions in the U.S.
- Replacing consumable carbon anodes with inert anodes, which would totally eliminate PFC emissions from primary reduction cells

APPLICATIONS

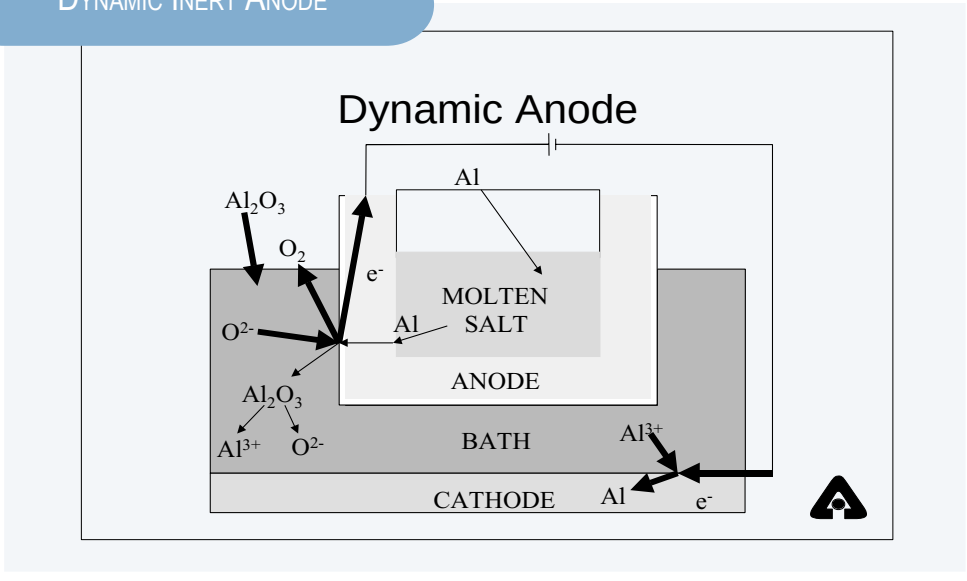
Aluminum is one of the most versatile materials available. Its light weight, high strength, and corrosion resistance make it ideal for applications in automobiles, trucks, rail, aerospace, containers, construction, electric transmission, and infrastructure. When used in transportation vehicles, it can greatly increase the energy efficiency of our Nation's transportation sector.

INERT METAL ANODES FOR PRIMARY ALUMINUM PRODUCTION

The development of dynamic metal inert anodes will permit further development of advanced electrolytic cells that consume significantly less energy and produce fewer greenhouse gas emissions. The Hall-Héroult electrolytic cell, developed over 100 years ago, is used to produce primary aluminum worldwide. Significant advances in cell technology have dramatically lowered electrical use in modern electrolytic cells to 13.6 kWh/kg. However, modern cells still consume large amounts of energy and produce significant emissions of greenhouse gases. Inert anode and wettable cathode systems offer the potential for new cell designs that will lower energy consumption by 25 percent and result in large reductions in greenhouse gases.

Most past and present investigations of inert anodes have focused on using ceramics and ceramic/metal materials. Metal anodes offer significant advantages including improved electrical conductivity, fracture toughness, thermal shock resistance, elimination of non-uniform current, and ease of fabrication into complex shapes for use in advanced cell designs. However, other than a few expensive noble metals, metals corrode in aluminum production cells. The project partners will develop a new inert hollow metal anode with a dissolving alumina surface film that is continuously replenished by aluminum additions to the interior of the anode. The role of the surface film is to protect the metal from corroding. In this project, metal alloys that form thin, self-limiting, self-healing alumina films will be evaluated for this new design.

DYNAMIC INERT ANODE



Inert metal anode protected by a self-limiting, replenishing alumina film.

Project Description

Goal: The goal of this project is to evaluate a metal inert anode that uses a thin surface film to protect it from the corrosive environment of aluminum electrolysis.

The objective of the research is to evaluate Argonne National Laboratory's concept of a metal inert anode, in which a thin surface film protects a metal anode from the corrosive environment of aluminum electrolysis. The work will consist of basic research on alloy film formation to aid in selecting a suitable candidate alloy, followed by bench-scale experiments performed at Argonne and culminating in a pilot test at Noranda Aluminum, Incorporated.

Progress and Milestones

- Investigate the surface compositional evolution of relevant alloys as a function of temperature and oxygen activity in well-defined and controlled environments.
- Measure the rates of surface segregation and oxidation as a function of oxygen partial pressure, alloy composition, and temperature.
- Identify promising inert anode materials.
- Perform electrolysis testing and evaluation in small 10A cells and in larger 100A cells.
- Conduct large-scale electrolysis tests at partner's plant smelter.
- Analyze the surface and interior of the anode to observe any variability as a result of testing.
- Determine the extent of anode corrosion and its effect on metal product purity.
- Determine the dimensional stability of the anode.

Commercialization Plan

The aluminum industry will have immediate access to the results upon successful completion of the pilot-scale cell testing through the Aluminum Association and industry conferences such as The Minerals, Metals & Materials Society (TMS) conference. It is expected that additional aluminum companies will join the project partners in new full pilot tests and with commercial demonstration of the technology. Argonne National Laboratory has the intellectual property rights to this technology. Any new technology developed from this research will be made available to domestic aluminum companies through licensing agreements with Argonne National Laboratory.

Project Partners

Argonne National Laboratory
Argonne, IL

Noranda Aluminum, Incorporated
New Madrid, MO

For additional information, please contact:

Project Information
Dr. J.N. Hryn
Argonne National Laboratory
Phone: (630) 252-5894
Fax: (630) 252-1342
hryn@anl.gov

Aluminum Program
Sara Dillich
Office of Industrial Technologies
Phone: (202) 586-7925
Fax: (202) 586-1658
sara.dillich@ee.doe.gov

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov.

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

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